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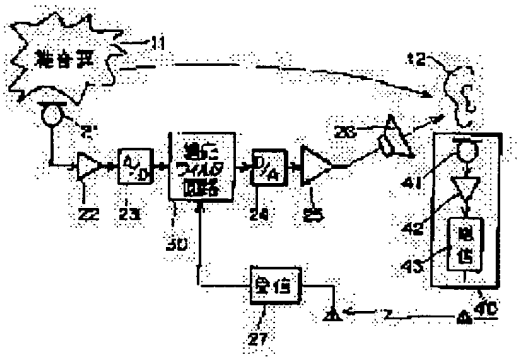
(54) NOISE REDUCING DEVICE

(57)Abstract:

PURPOSE: To obtain the best noise reduction effect at all times even if a head changes in position or direction.

CONSTITUTION: A canceling sound generating means 30 generates a canceling sound for canceling a noise gathered by a microphone 21 for reference input. A speaker 26 radiates the canceling sound from the canceling sound generating means 30. The noise residual in a sound field whose noise is reduced with this canceling sound is gathered by a microphone 41 for residue detection which is fitted to an accessory and fixedly installed nearby an ear 12. The residual signal of the microphone 14 for residue detection is supplied to the canceling sound generating means 30, which makes an adjustment so that the residue is minimized.



LEGAL STATUS

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EFFECT OF THE INVENTION

[Effect of the Invention] Since the microphone for remainder detection is attached in accessories and it enabled it to install it fixed near the ear in active mold noise reduction equipment according to this invention as explained above, even if there are movement of the head and change of a direction, the early noise reduction effect can always be acquired. Moreover, since noise reduction area is always near the ear, the head and the body can be moved freely. Since there is no troublesome signal line while the flexibility of movement increases when a remainder signal is transmitted especially on radio, various work can be done freely.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the small active mold noise reduction equipment which reduces noise acoustically.
[0002]
[Description of the Prior Art] The equipment called from the former activity type noise reduction equipment is known. Although the noise to which this was emitted from the noise source reaches human being's ear through a spatial path, it is a system which carries out sound emission of the acoustic wave of an antiphase from a loudspeaker with an amplitude equal to the noise from a noise source, and reduces noise [near the ear].
[0003] In this kind of noise reduction equipment, a noise signal (this noise signal has very strong correlation by noise from a noise source) is collected with the microphone for a reference input installed near the noise source, it denies from this noise signal and the sound signal for negating noise near the ear is formed by the sound formation circuit. And this denial sound signal is supplied to a loudspeaker, and the noise near the ear is reduced. And the microphone for remainder detection which collects the noise remainder is arranged near the ear, and the detecting signal from this microphone for remainder detection is negated, and it feeds back to a sound formation circuit, and is made to adjust in this denial sound formation circuit, so that the noise remainder may become the minimum.
[0004] In this active mold noise reduction equipment, it is desirable to install the microphone for remainder detection an auditory-meatus entrance or near the eardrum as much as possible, and the amount of noise reduction becomes small, so that it separates from the position. When applied to the crew of the former, for example, the aircraft, this microphone for noise remainder detection is made to be fixed near crew's ear by supporter material, such as a seat and a headrest.
[0005]
[Problem(s) to be Solved by the Invention] However, it was difficult for a seat, a headrest, etc. to have to install the microphone for remainder detection in the position distant from close to his ears as mentioned above, in order to have to take into consideration individual differences, such as a size of people's head, and how to sit down, the need of allowing a certain amount of [motion / the head] flexibility, etc., when installing the microphone for remainder detection in the position distant from the human body, and to fully bring the microphone for remainder detection close to an ear. Consequently, there was a fault from which sufficient amount of noise reduction is not obtained.
[0006] Moreover, in the conventional system, since the microphone for remainder detection separates with a human body, is fixed physically and it is attached, if the area where noise is reduced is restricted and there is no ear into the area, the predetermined amount of noise reduction will not be obtained. For this reason, there was a fault that movement with the free head was restricted.

[0007] In view of the above point, even if this invention has movement of the head, and change of a direction, it aims at offering the noise reduction equipment which can always obtain sufficient amount of noise reduction.

[0008]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the noise reduction equipment by this invention The microphone 21 for a reference input for collecting noise, if the reference mark of the below-mentioned example is made to correspond, The denial sound means forming 30 which forms the denial sound for negating this noise from the noise which collected the sound with this microphone 21 for a reference input, The sound emission means 26 for carrying out [sound / denial] sound emission in response to the sound signal from this denial sound means forming 30, It has the microphone 41 for remainder detection for collecting the noise remainder in the sound field by which sound emission was carried out from this sound emission means 26 and to which it denied and noise reduction was carried out [sound]. The remainder signal collected with the microphone 41 for remainder detection denies, and the sound means forming 30 is supplied. It is made to be adjusted in this denial sound means forming 30, so that the aforementioned remainder may become the minimum, and the microphone 41 for remainder detection is attached in accessories 50. In addition, these accessories are good in their being that with which a head is equipped, for example, spectacles, and a hair band.

[0009]

[Function] In this invention constituted as mentioned above, the microphone 41 for remainder detection is attached in the accessories with which a human body is equipped, and is installed near the ear. Since a human body is equipped with the microphone for remainder detection, the predetermined amount of noise reduction is related always obtained by movement of the head, and direction change.

[0010]

[Example] The case of the ecad noise reduction equipment which performs adaptation processing for one example of the noise reduction equipment by this invention using an adaptation filter circuit is hereafter taken for an example, and it explains, referring to drawing.

[0011] Ecad noise reduction equipment is explained referring to drawing 3 , before explaining the example of this invention. In drawing 3 , 1 is a main input terminal, 2 is a reference input terminal, and the signal inputted through the main input terminals 1 is supplied to the synthetic circuit 4 through a delay circuit 3. Moreover, the signal inputted through the reference input terminal 2 is supplied to the synthetic circuit 4 through the adaptation filter circuit 5, and is subtracted from the signal from a delay circuit 3. And the output of this synthetic circuit 4 is drawn by the output terminal 6 while it returns to the adaptation filter circuit 5.

[0012] It sets to this noise reduction equipment, and is the noise n0 of the signal s of choice, this, and no correlating with the main input terminals 1. What was added is inputted. On the other hand, in the reference input terminal 2, it is noise n1. It is inputted. Noise n1 of this reference input The signal of choice is noise n0, although not correlated. It is made for there to be correlation.

[0013] The adaptation filter circuit 5 is the reference input noise n1. It filters and is noise n0. The signal y to approximate is outputted. The signal of amplitude, such as noise and an antiphase, can be acquired as an output signal y of this adaptation filter circuit 5. In the synthetic circuit 4, processing which subtracts the output signal of the adaptation filter circuit 5 from the output signal of a delay circuit 3 is performed. A delay circuit 3 is for carrying out time doubling of the signal which carries out subtraction processing in consideration of the processing time in the adaptation filter circuit 5.

[0014] The algorithm of the adaptation in the adaptation filter circuit 5 works so that the subtraction output (remainder output) e which is an output of the synthetic circuit 4 may be made into the minimum. That is, if s, n0, n1, and y assume now that it is statistically regular and the average is 0, the remainder output e will be set to e=s+n0-y. For expected value, s is n0 although this was squared. Since it did not correlate with y again E [e2] =E[s2]+E [(n0-y)2] +2E [s (n0-y)]

=E[s2]+E[(n0 -y)2]
It becomes. The thing which the adaptation filter circuit 5 converges, then the adaptation filter circuit 5 are adjusted so that E [e2] may become the minimum. Since E [s2] is not influenced at this time Emin [e2] =E[s2] +Emin [(n0-y)2]
It becomes. That is, by minimizing E [e2], E [(n0-y)2] is minimized and the output y of the adaptation filter circuit 5 is noise n0. It becomes estimate. And the expected value of the output from the synthetic circuit 4 serves as the signal s of choice. That is, adjusting the adaptation filter circuit 5 and minimizing full power power has the subtraction output e equal to the least squares estimate of the sound signal s of choice to a bird clapper.
[0015] In addition, either in the case of realizing in the case where it realizes in an analog signal processing circuit, and a digital-signal-processing circuit is possible for the adaptation filter circuit 5. The example at the time of realizing the adaptation filter circuit 5 using a digital filter is shown in drawing 4 . The so-called LMS (the minimum average square) method is used for this example as an algorithm of adaptation.
[0016] As shown in drawing 4 , in this example, the FIR filter type adaptation linear combination machine 300 is used. This is [two or more delay circuits DL1 and DL2 which have the time delay Z-1 of the unit sampling time, respectively, ...DLm (m is a positive integer) and] the input noise n1. And it has the adder circuit 310 adding each delay circuits DL1 and DL2, the load circuits MX0, MX1, and MX2 which perform multiplication of the output signal of ..DLm, and a weighting factor, ..MXm, and the output of the load circuits MX0-MXm. The output of an adder circuit 310 is y.
[0017] The weighting factor supplied to the load circuits MX0-MXm is the LMS arithmetic circuit 320 which consists of a microcomputer, and is formed based on the remainder signal e from the synthetic circuit 4. The algorithm performed in this LMS arithmetic circuit 320 is as follows.
[0018] Now and time k Input vector Xk which can be set As shown also in drawing 4 , it is Xk =[x0k x1k x2k. ... It is [0019], as input / output relation shows yk and a weighting factor to the following several 1 for it by being referred to as xmk]T, when an output is set to wjk (j= 0, 1 and 2, --m).
[Equation 1]

$$y_k = \sum_{j=0}^{m} w_{jk} x_{jk}$$

It becomes.
[0020] And time k Load vector Wk which can be set Wk =[w0k w1k w2k ... If it is defined as wmk]T, input/output relation will be given by yk =Xk T and Wk. Here, it is dk about the response of hope. Then, the remainder ek It is expressed as follows.
With ek =dk-yk=dk-Xk T and the WkLMS method, it is Wk+1 =Wk+2 micro-ek about renewal of a load vector. The formula which becomes -Xk performs one by one. Here, mu is an advantage factor (step gain) which determines the speed and stability of adaptation.
[0021] With the active mold noise reduction equipment which is the object of this invention, the synthetic circuit 4 serves as a sound composition means. That is, by the adaptation filter circuit 5, an amplitude does noise denial sound signal-y formation of noise, an antiphase, etc., this is supplied to a loudspeaker etc., and it considers as the composition which adds to main voice acoustically and carries out noise reduction. the remainder e in this case collects a sound with the microphone for remainder detection -- things -- **
[0022] Drawing 1 is the block diagram of one example of the noise reduction equipment by this invention. In this example, that for which the adaptation filter circuit used the digital filter is used. And only the noise source 11 is considered as a main input. As the noise from this noise source 11 is shown in drawing, it is spread to an ear 12.
[0023] 21 is a microphone for a reference input, is arranged near the noise source 11 and collects the noise

inputted into an ear, and noise with correlation. The signal which was collected with this microphone 21 for a reference input, was changed into the electrical signal, and was acquired is supplied to A/D converter 23 through amplifier 22, is changed into a digital signal and supplied to the adaptation filter circuit 30. And the output signal of this adaptation filter circuit 30 is returned to an analog sound signal by D/A converter 24, and is supplied to a loudspeaker 26 through amplifier 25. And sound emission is carried out [sound / noise denial] by this loudspeaker 26, it is acoustically compounded with the noise acoustic wave from a noise source 11, and the noise from a noise source 11 is reduced / near the ear 12 /.

[0024] And the remainder radio-transmission unit 40 equipped with the microphone 41 for remainder detection near this ear 12 is installed. As this unit 40 shows drawing 2 in this example, it is attached in the frame 51 of spectacles 50, and when the microphone 41 for remainder detection equips with spectacles, it is constituted so that it may be located near the entrance of auditory meatus.

[0025] The remainder radio-transmission unit 40 is equipped with the amplifier 42 and the radio sending circuit 43 other than the microphone 41 for remainder detection. The power supply for driving this radio-transmission unit 40 may be carried in a unit 40, it is made to build in the spectacles frame 51, or a frame 51 can be equipped with it. And the remainder of the auditory-meatus entrance of the ear 12 collected with the microphone 41 for remainder detection is supplied to the radio sending circuit 43 through amplifier 42, and is transmitted to the radio receiving circuit 27 as an electric wave. The remainder received by this radio receiving circuit 27 is supplied to the adaptation filter circuit 30. This application filter circuit 30 adjusts the output signal-y so that the remainder may serve as the minimum.

[0026] In this way, noise reduction is carried out in adaptation so that the noise in the auditory-meatus entrance of an ear 12 may become the minimum. And in this example, the predetermined amount of noise reduction can always be obtained, without giving inconvenient to the movement of human being's head, and human being's own movement, since the microphone 41 for remainder detection is attached in the spectacles 50 with which human being is equipped and it is installed in a human body fixed regardless of movement of the head near the auditory-meatus entrance of an ear 12. Furthermore, in this example, since the remainder signal was transmitted on radio, there is no troublesome signal line and free movement can be secured.

[0027] Although the frame of spectacles is equipped with the radio-transmission unit 40 equipped with the microphone 41 for remainder detection and the microphone 41 for remainder detection was installed near the ear 12 in the above-mentioned example As a member equipped with the radio-transmission unit 40, not only this but a hat, a hair band, IARINGU, etc. may be the accessories which human being uses, and as long as it is possible to install the microphone for remainder detection near the ear, what thing may be used.

[0028] Moreover, as another object, the microphone 41 for remainder detection and the radio sending circuit 43 connect between both with a signal line, and can use the radio sending circuit 43 as a carried type. In this case, a cell is formed in a carried type radio sending-circuit side, and the supply voltage for operating the microphone 41 for remainder detection can also give it through a code. Moreover, in the above example, a remainder signal may use the radio-transmission means using infrared radiation, an ultrasonic wave, a laser beam, etc., although it was made to transmit through radio.

[0029] In addition, it cannot be overemphasized by the remainder signal that it does not transmit on radio but you may make it transmit to the application filter circuit 30 through a signal line.

[0030]

[Effect of the Invention] Since the microphone for remainder detection is attached in accessories and it enabled it to install it fixed near the ear in active mold noise reduction equipment according to this invention as explained above, even if there are movement of the head and change of a direction, the early noise reduction effect can always be acquired. Moreover, since noise reduction area is always near the ear, the head and the body can be moved freely. Since there is no troublesome signal line while the flexibility of movement increases when a remainder signal is transmitted especially on radio, various work can be done freely.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of one example of the noise reduction equipment by this invention.
[Drawing 2] It is drawing for explaining an example of the important section of this invention.
[Drawing 3] It is drawing for explaining an example of ecad noise reduction equipment.
[Drawing 4] It is drawing showing an example of an adaptation filter circuit.
[Description of Notations]
11 Noise Source
12 Ear
21 Microphone for Reference Input
26 Loudspeaker Which Carries Out [Sound / Denial] Sound Emission
30 Application Filter Circuit
40 Remainder Radio-Transmission Unit
41 Microphone for Remainder Detection
42 Radio Sending Circuit

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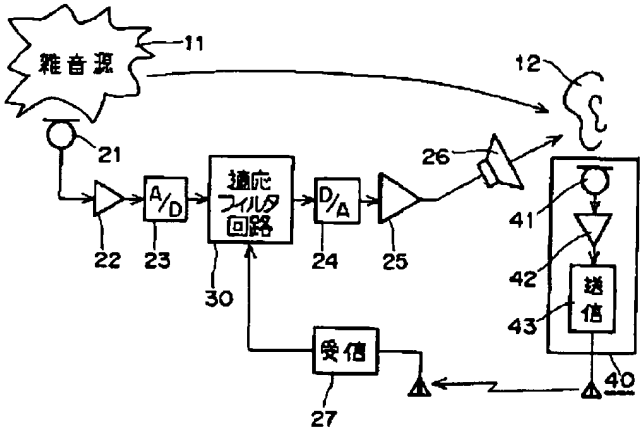
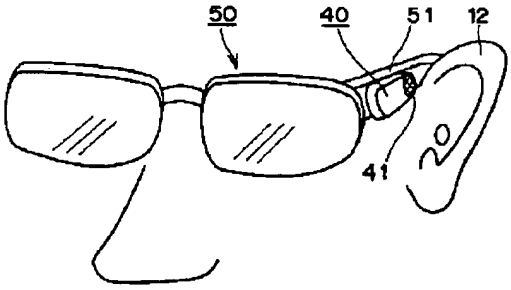
DRAWINGS

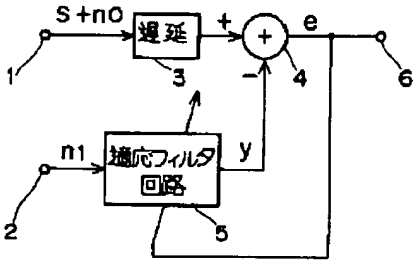
[Drawing 1]



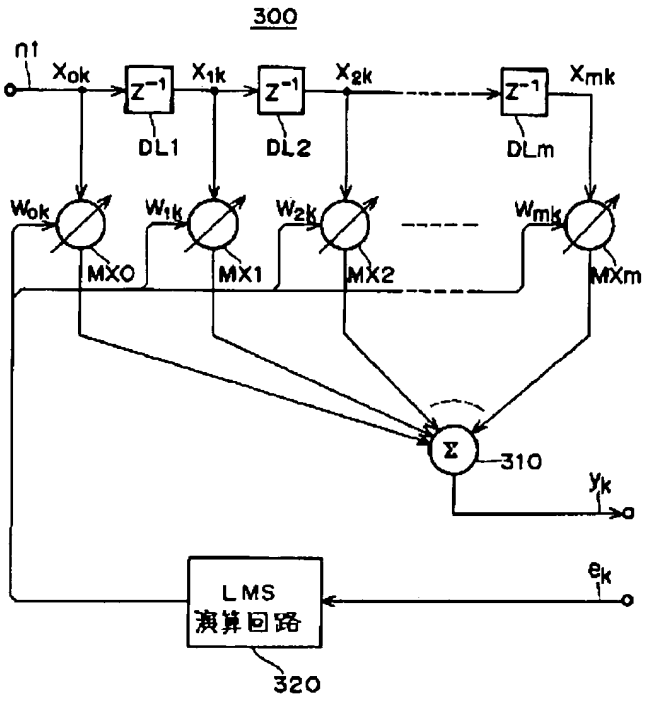
[Drawing 2]



[Drawing 3]



[Drawing 4]



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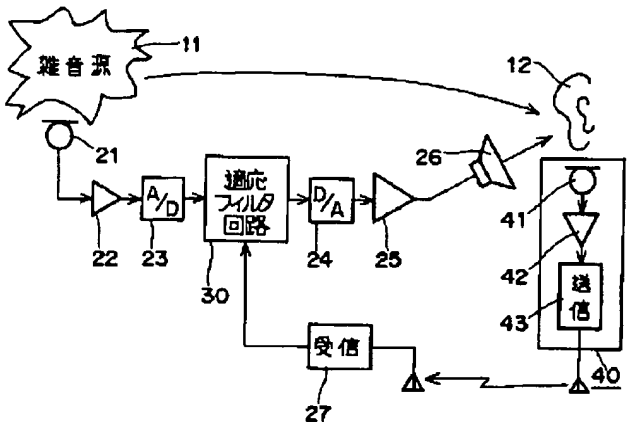
Drawing selection [Representative drawing]



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